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PROCEEDINGS OF

# THE LINNEAN SOCIETY OF LONDON

**Session 1931–32**

PART I (pp. 1–16)

**NOTICE**

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# PROCEEDINGS

OF

# THE LINNEAN SOCIETY OF LONDON

(ONE HUNDRED AND FORTY-FOURTH SESSION, 1931–1932)

## GENERAL MEETINGS

22 October 1931

Professor F. E. Weiss, F.R.S., President, in the Chair

The Proceedings of the Anniversary Meeting held on Thursday the 28th May 1931, having been circulated, were taken as read and confirmed.

The President said that before beginning the proceedings of the meeting he desired to express his thanks to the Fellows for the honour they had done him in electing him to the presidency. It was an honour which he greatly appreciated, and he wished to assure the Fellows that he would endeavour to the best of his ability to further the interests of the Society.

The President referred to the untimely death of Major Chipp, by which a useful member of the Council had been lost and by which science had lost a promising botanist. He stated that the Council had expressed to Mrs. Chipp their sympathy with her in her bereavement.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table. Special mention was made of the donation from Miss E. C. Hatchett Jackson of a marble bust of Charles Hatchett,

one of the fourteen Fellows mentioned in the first Charter of the Society, the work being by Sir Francis Chantrey; also of a donation from Major VIVIAN SEYMER, D.S.O., M.C., of some volumes from the library of his ancestor, Henry Seymer, a friend of A. Bourke Lambert.

The following Fellow signed the Obligation in the Book of the Charter and Bye-Laws and was admitted:—Clive Errol Lord.

Certificates of recommendation of the following candidates for Fellowship were read:—For the first time, in favour of Norman Loftus Bor, Wilfred Edward Shewell-Cooper, Francis Ralph Tubbs, Marion Evelyn Odell, Edmund William Mason, Syed Hedayetullah, James Philp, and Edavaleth Kakkat Janaki-Ammal.

The PRESIDENT stated that the Society would be glad to hear that HIS IMPERIAL MAJESTY THE EMPEROR OF JAPAN had accepted the invitation of the Council to become an Honorary Member. The Emperor of Japan was genuinely interested in botanical science. He had a private botanical garden and laboratory, and on the journeys he undertook before his accession to the throne he studied both the floras and faunas of the countries he visited.

The election, by open vote, was unanimous, all present rising in their places.

The following letter had been received from the Japanese Ambassador:—

JAPANESE EMBASSY,
London, W.
August 11th, 1931.

Sir,

The contents of your letter of January 9th last, enquiring whether His Majesty the Emperor of Japan would consent to be proposed as an Honorary Member of the Linnean Society of London, have been sent to the Foreign Office, Tokyo, for their submission to the high destination.

I beg to state that I have now received the reply from Tokyo to the effect that His Imperial Majesty will be pleased to accept the Honorary Membership which the Council of the Society proposes to extend to him.

I am, Sir,
Your obedient Servant,
T. MATSUDAIRA.

Sir SIDNEY F. HARMER, K.B.E.,
President,
The Linnean Society of London.

The PRESIDENT having, in accordance with previous announcement, declared the Meeting to be made a Special General Meeting for the election of a Member of Council in the place of the late Major T. F. Chipp, the Assistant Secretary read the Bye-Laws governing such election, and the Fellows present proceeded to vote.

The Ballot having been closed, the President appointed Mr. J. T. Cunningham, Dr. E. J. Collins and Mr. T. A. Dymes, Scrutineers; and the Votes having been examined and cast up they reported to the President, who declared that Dr. H. Hamshaw Thomas had been elected a Member of Council.

**Structural diversity in Charadriine genera correlated with similarity of colour-pattern. By Mr. Percy R. Lowe.**

Mr. LOWE exhibited a double series of Plovers arranged in two rows of eight apparently nearly related, or closely linked-up, couples. All these species belonged to one sub-family—the Charadriinae—and each species of any given couple belonged to a definitely recognizable and distinct genus. The Charadriinae are world-wide in distribution and the species forming the exhibit were drawn from every continent.

In each of these two series of Plover species a curious condition of diversity in skull-structure was illustrated. This diversity was constant throughout either series; and was correlated with, or camouflaged by, an almost identical similarity of coloration or colour-pattern, occurring in the plumage of each species of any given couple. The similarity in coloration, or colour-pattern, which existed between the species forming any given couple was so striking that the difference which actually existed could be expressed only by describing it as either an adumbration or an accentuation of the coloration or colour-pattern.

Correlated with either this adumbration or accentuation of coloration or colour-pattern, was found a parallel, or similar kind of adumbration (? less specialized) or accentuation (? more specialized) in the structure of the skull. In one couple, viz., that represented by the grey and golden Plover, the skull of the immature golden Plover passed through an antecedent stage characteristic of the adult grey Plover. Owing to lack of material it was not possible to say if this condition obtained in the other couples exhibited.

To sum up—there was in the top series exhibited an "adumbration" of coloration, colour-pattern, and skull structure; in the bottom series an "accentuation" of all three.

In attempting to seek an explanation of this diversity in the two series the factors of habit and environment as causative agents had been very carefully considered. On the evidence available both apparently had to be rejected. The suggestion

advanced was that the facts might be capable of explanation if we supposed that in the "adumbrated top row" we had a series of species which were antecedent in point of time and origin to the series in the bottom row.

If this were so it naturally seemed to follow that we had the varying effect of both Time and Evolution represented simultaneously in a series of species living in the present epoch which, more often than not, were closely associated as regards habit, environment, and range. In other words, it was possible to find in a community of Plovers existing at the present time and belonging to what was by general consent considered to be the same subfamily representatives of two different geologic horizons. The amazing persistence of avian types rendered such a conception more plausible than we might at first sight be inclined to admit.

Another explanation which might have to be considered was possibly to be sought in what Mr. Lowe briefly referred to as a Salt and Fresh water theory. This took us back to the vast fresh water lakes, lagoons, morasses, and marshes of Miocene and Pliocene Eurasia which, Mr. Lowe suggested might possibly have provided an isolating factor in causing the morphological divergence already noted.

Finally, there seemed reason to suspect from what Mr. Lowe had already noted that the phenomena which he had demonstrated might occur in other groups of birds. One of the objects of the demonstration, he said, was to elicit information as to whether a parallel condition of things was known to workers in other branches of Zoology.

The PRESIDENT expressed his interest in Mr. Lowe's paper and particularly in the correlation of two such distinct characters as external coloration and internal anatomical structure, which seemed to have no obvious connection.

Dr. W. T. CALMAN remarked that Mr. Lowe's exhibit presented in a very striking and dramatic form a problem with which systematic biologists were constantly meeting. When the systematic relationships inferred from two systems of organs were irreconcilable, it was necessary to choose the characters of one system as indicating phylogeny, and to attribute the resemblances in the other system to convergence. In the present instance the basing of phylogeny on the skull-characters involved the assumption that the parallelisms of plumage-pattern pointed out by Mr. Lowe had each originated independently. It might be worth while enquiring whether independent origin of the skull-characters was not more probable. It could not be assumed that superficial characters were necessarily less indicative of affinity than those which lay below the surface.

Mr. J. T. CUNNINGHAM suggested that the similarity of

colour-pattern in the two series of genera was a case of parallel mutation. He pointed out that under domestication there occurred a remarkable parallelism in the colour-mutations not only of different genera, but even of animals of different families and different classes. For example in mice, rabbits, cattle, cats, and even in horses and dogs, as well as in pigeons and poultry similar colour-mutations had occurred, such as white, black, piebald, red, yellow, brown, grey, blue (i.e. diluted black), and various intermediate colours and patterns, although there were often markings peculiar to the original genus or species, such as spotting in horses, wing-bars in pigeons, stripes in cats, etc.

Sir SIDNEY HARMER asked Dr. Lowe to explain whether the two members of each of the pairs of species were always found in the same locality. He stated that in the Polyzoa he had himself found similar evidence of the different conclusions as to the evolution of species which might be deduced from the study of two different sets of structures.

Dr. G. P. BIDDER wished to rectify Dr. Calman's statement, that systematists classify only by characters which are difficult to ascertain. The apparent principle of conventional classification is to take into account only the mineral excretions retained in or about the animal's body, any part which has lived being *ipso facto* disqualified as evidence regarding the creature's relationship. (It should be added that the harder sclero-proteins, such as horn and chitin, are commonly given courtesy rank of minerals in proportion to their inert seclusion from life.) Grave errors result from the fact that insoluble residues of metabolism are largely dependent, for their quantity and locality, on changes in physico-chemical environment.

Mr. CLIVE E. LORD stated that the Australian examples, whilst being birds from apparently the same environment were not entirely so. One species was generally found on damper ground than the other. The food obtained from the two areas would probably differ and influence to a considerable degree the structure and coloration of the species. Food values and details of environment need to be studied in conjunction with the differences of coloration and structure.

Mr. W. P. PYCRAFT also spoke.

Mr. LOWE briefly replied, and the PRESIDENT expressed the thanks of the meeting to him.

**The circulation of blood in the air-breathing chambers of Ophiocephalus punctatus Bloch. By Mr. S. H. Lele. (Communicated by Dr. S. L. Hora.)**

Dr. S. L. HORA made a brief reference to the habits of the Ophiocephalid fishes and gave an account of the form, position, and associated structures of the air-breathing chambers of

*Ophiocephalus punctatus*. Attention was directed to the highly vascular nature of the relatively thin and so-called 'practically non-vascular' membrane lining the roof of the air-chambers. As regards circulation it was indicated that the first and second branchial arteries after giving small branches to the gills were continued as large vessels to supply blood to the air-chambers. The capillaries of the air-chambers drained into the tributaries of the anterior jugular vein. Special attention was directed to the fact that the oxygenated blood was thus mixed up with the venous blood. The third and fourth afferent arteries after giving small branches to the gill-filaments were continued as large vessels to join the suprabranchial of their side. In this way the blood passed through them directly to the central arterial system without oxygenation in the branchial filaments of the gills. These modifications of the branchial arteries clearly indicated that the air-chambers played an important part in the respiration, and that mixed blood was supplied to the body as arterial blood. It was suggested that this defective circulation may have induced the evolution of the four-chambered heart of the higher vertebrates from the two-chambered heart of fishes.

In conclusion, Dr. Hora directed attention to the great advance that has been made in the study of animal characters on the one hand and to the paucity of our knowledge regarding factors in their habitats on the other. It is mainly due to this that we are unable to judge the value of certain characters, for the utility of a structure can be judged only by reference to its function in relation to a certain factor or factors in an environment.

Mr. J. T. Cunningham thought it possible that the difference in the relations of the blood-vessels in the two species compared might be due to the fact that the two species were distinct before the evolution of the air-breathing organs began, and that therefore the latter were evolved independently.

Mr. J. R. Norman having also commented on the paper, the President expressed the thanks of the meeting to Dr. Hora and Mr. Lele.

### Exhibit of dried specimens of the yellow-flowered Privet. By the Rev. H. J. Riddelsdell.

The Botanical Secretary read a letter from, and exhibited on behalf of, the Rev. H. J. Riddelsdell, dried specimens of a yellow-flowered privet from Goring, Oxfordshire.

Mr. T. A. Dymes said that he had seen a yellow-flowered privet this year in Hampshire and that it was also known in Sussex. It appeared to differ from the normal *Ligustrum vulgare* Linn. not only in the colour and size of the flowers,

but also in the shape of the leaves and the larger inflorescence. It had been suggested at the Kew Herbarium that it might be a form or a sport of *L. vulgare*, but so far the data were far too few for forming an opinion ; we did not as yet know what the berries were like.

Dr. A. B. RENDLE mentioned a reference in Hegi's Illustr. Flora Mittel-Europa to a yellow-flowered form described as a definite entity—var. *auriflorum* Hoefk. ; localities are cited in the Tirol and the Vorarlberg.

The PRESIDENT stated that he had himself never seen a yellow-flowered privet, and he wondered whether in other countries where the privet was more at home yellow-flowered privets were more common.

Prof. R. R. GATES said that although the yellow-flowered variety of privet was apparently rare and the white-flowered variety the common one, yet it was possible that the yellow variety was the original one which had given rise to the white, since mutations in the opposite direction were very rare.

**A study of the changes following the removal of Subalpine Forest in the vicinity of Arthur's Pass, Southern Alps, New Zealand. By Dr. L. Cockayne, C.M.G., F.R.S., and Dr. W. A. Sledge.**

Dr. W. A. SLEDGE gave the following account of this paper :—

The area investigated was denuded of all vegetation by burning twenty-three years ago, since when a new vegetation has developed on the bare ground. The topography and general ecological conditions of the district were first described and a short account given of the original vegetation which covered the area, as represented by the existing forest which still surrounds it. This consists of low subalpine beech forest with *Nothofagus cliffortioides* as the sole tree but with a large number of associated shrubs, the majority of which though well able to grow in the open are not present in the new vegetation, whilst *Cassinia Vauvilliersii* which is abundant in the new vegetation is absent from the forest.

In the new vegetation series of transitions can be seen from preliminary colonization of bare ground up to the establishment of four definite and distinct communities, viz. :—Herbfield, Shrubland, Bog, and Tussock-grassland.

Stages of primary colonization were outlined dealing with the formation of the herb-field association, the principal dominants of which in different parts were species of *Celmisia* (especially *C. Armstrongii* and *C. coriacea*), *Danthonia Raoulii*, *Phormium Colensoi*, and *Ranunculus Lyallii*. Further stages in succession have led to the formation of shrubland through the invasion of herbfield by shrubs. Intermediate associations

are much in evidence, but in many places shrubland is already well established, and in such places the herbaceous and semi-woody plants of the open herbfield have been replaced by other shade-tolerating plants below the shrubs. The number of shrubby species is small, the two dominants being *Dracophyllum longifolium* and *Cassinia Vauvilliersii*, and there is as yet no sign of recolonization by *Nothofagus*.

The bog and tussock grassland associations are less widely developed and the former shows good evidence of undergoing a transition into tussock-grassland dominated by *Danthonia Raoulii*.

Observations on the floristic composition of the vegetation showed that although at least fifty exotic plants were established within two kilometres of the area none had succeeded in establishing themselves in competition with native species on the area and only a few isolated individuals of *Hypochaeris radicata* and *Holcus lanatus* were noted amongst a hundred species of native plants. Equally striking but less readily accounted for was the absence of species of *Acaena* on the area, though the genus is well represented near by.

The PRESIDENT asked Dr. Sledge how scrub-vegetation to which he referred as superseding the herbaceous vegetation established itself. Were the seeds windborne and was there any similar formation in the neighbourhood? He would also like to know whether a long time elapsed before the scrub-vegetation began to replace the herbaceous plants?

Dr. A. B. RENDLE asked whether, in view of the fact that the original vegetation had been destroyed twenty-three years ago, the observations described by Dr. Sledge formed part of a series extending over the period since the destruction or were merely a single chapter in the vegetation changes? Were the gradations from herb-field to bushland described as now existing to be regarded as typical of the course of repopulation during the twenty-three years?

Mr. CLIVE E. LORD, commenting on the absence of *Nothofagus* in the new vegetation, mentioned that in Tasmania the *Nothofagus* forests are retrogressive and fail to re-establish themselves in felled areas. Had the forest been *Eucalyptus* there would have been rapid natural re-afforestation after clearing.

Mr. J. RAMSBOTTOM congratulated Dr. Sledge on his paper and also on the opportunity he had had of working in collaboration with Dr. Cockayne who had done so much to advance our knowledge of New Zealand vegetation. The fact that *Nothofagus* appeared to be dying out was of great interest from the point of view of geographical distribution. Had Dr. Sledge noticed much disease or any parasitic fungus in addition to *Cyttarea* which was restricted to *Nothofagus*?

Dr. Sledge replied to the questions and added that grazing was more of a casual than persistent nature. The source of the different components of the shrub-flora in the new vegetation as compared with the adjacent forest was probably the open shrubby ground on Arthur's Pass beyond the surrounding forest.

A vote of thanks to the authors concluded the meeting.

## 5 November 1931

Professor F. E. Weiss, F.R.S., President, in the Chair

The Proceedings of the Special General Meeting held on Thursday the 22nd October 1931, having been circulated, were taken as read and confirmed.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

The following Fellows signed the Obligation in the Book of the Charter and Bye-Laws and were admitted: Joseph Davenport Snowden, Lt.-Col. Leonard Charles Rudolph Messel, and Yajñavalkya Bhâradwâja.

Certificates of recommendation of the following candidates for Fellowship were read:—For the second time, in favour of Norman Loftus Bor, Wilfred Edward Shewell-Cooper, Francis Ralph Tubbs, Marion Evelyn Odell, Edmund William Mason, Syed Hedayetullah, James Philp, and Edavaleth Kakkat Janaki-Ammal.

### Naturalization of Sarracenia purpurea in Switzerland. By Professor F. E. Weiss, F.R.S., Pres.L.S.

The President (Prof. F. E. Weiss) exhibited some specimens of *Sarracenia purpurea* collected by him in Switzerland at an altitude of 3,700 ft. At the top of an upland valley on the slopes of the Pleiades above Vevey on approaching the watershed an expanse of marshy ground occurs with a plentiful growth of *Sphagnum* and small patches of open water. Here some twenty years ago one or more plants of *Sarracenia purpurea* were planted by a local botanist, and these have not only established themselves but have spread by seeding over a considerable area. *Sarracenia purpurea* can therefore be said to have naturalized itself there, and it is mentioned in the local list of native plants protected by Cantonal regulations. Of the seven species of *Sarracenia* which are all native to the Eastern states of North America *Sarracenia rubra* alone ascends to a height of 2,000 ft. in the mountains of North

Carolina. All the others are more or less restricted to low-lying regions. *S. purpurea*, however, has a very wide distribution, reaching westward to central Canada and northwards to Labrador. It is found therefore in its native country under very varying climatic conditions, adapted not only vegetatively to extreme cold as well as to a mild climate, but also showing a great range in the time of its flowering. Thus in Florida it flowers in the first week of April, in New Jersey in May, in Maine in July, in Newfoundland and Labrador in August. In Switzerland it was flowering last year towards the end of June. It is obvious that a plant living in such very different latitudes in America could easily be acclimatized at considerable altitudes as in this upland valley of Switzerland.

Dr. G. P. Bidder, Vice-President in the Chair, having asked for a discussion on Professor Weiss's remarks, the following observations were made :—

Dr. A. B. Rendle, recalling specimens of *Sarracenia purpurea* that he had collected in Holland Marsh north of Toronto near the northern limit of distribution of the genus, remarked on the small size of the specimen shown by the President. He suggested that the altitude at which the species was growing in Switzerland might explain the dwarfing.

Sir Arthur W. Hill said that he understood that *Sarracenia purpurea* had been planted in a garden in N. Wales in the Conway Valley and had naturalized itself there.

Mr. I. H. Burkill spoke of botanizing, at the end of a period of drought, in a Florida swamp where every *Sarracenia* leaf was found to have been bitten through by some thirsty animal in a hunt for water. The animal may have been a terrapin, and the hole was bitten in the region towards the base where carcases of flies etc. had accumulated.

Dr. L. Darker (Visitor) also spoke ; and the thanks of the meeting were conveyed to Professor Weiss after he had replied to questions.

### A new Juncus in Scotland. By Mr. H. W. Pugsley.

Mr. H. W. Pugsley exhibited specimens of a *Juncus*, collected in 1892 in Ross-shire by the late Rev. E. S. Marshall, which is being described in the ' Journal of Botany ' as a new species. He pointed out that Marshall, at the time of its discovery, believed it to be distinct from the known British species, but did not continue the investigation after Buchenau had referred it to a form of *J. alpino-articulatus* Chaix (*J. alpinus* Vill.). Specimens of *J. alpino-articulatus* from Teesdale, Savoy, and Dauphiny, and of *J. nodulosus* Wahlb. from Scandinavia were also shown to illustrate the distinctive characters of the new plant.

Mr. A. J. Wilmott gave an account of his hurried visit to Loch Ussie with the Treasurer last year, when they failed to rediscover the plant. He suggested that it might be on the rocky margin which they avoided as unsuitable for *Junci*.

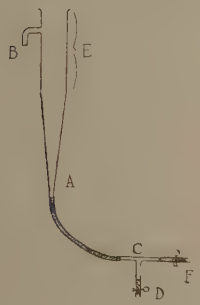
The President expressed the thanks of the meeting to Mr. Pugsley.

## Elutriation and some of its applications to biology.

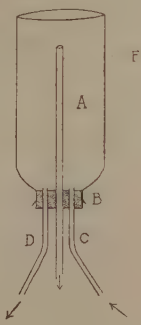
By Mr. A. G. Lowndes.

*Introduction.*—The process of elutriation, or the separation of the finer particles of a powdered substance by washing, has been used in mineralogy and various industries for years, but apparently it has never been applied to biological problems. Recently I have had occasion to use it and it is thought that a description of the apparatus and some of its applications might be put on record in biological literature.

Text-fig. 1.




Text-fig. 2.




*Instrument.*—The instrument (text-fig. 1) consists essentially of a wide glass tube about two feet long and three inches internal diameter. The lower half is drawn out to a long cone which forms the bottom of the instrument. The narrow end is cut off and fused on to an ordinary piece of glass tubing, A, having an internal diameter of half an inch or a quarter according to the purpose of the instrument. Near the top of the instrument a small glass tube B bent at right angles is fused on, forming of course the outflow. A is attached to a fine rubber tube which is itself attached to a T-tube C bearing a clip D. The other end of this tube is attached to the water-tap or possibly to a water-container or reservoir (to be described later).

*Principle.*—Water enters the elutriator at A at a certain definite rate, and of course produces an upward current through the apparatus, and finally flows out at B. Now if the rate of the inflow is kept constant the rate of the upward current through the elutriator must vary inversely as the square of the diameter of the tube. If the diameter of the bottom tube is half an inch and that of the straight part E be three inches, the current in the one will be thirty-six times that of the other. In other words, if we call the current at E unity the current at A will be thirty-six. If the diameter at A is a quarter of an inch the relative currents will be 1 : 144. Now it is a matter of common knowledge that the size of particles which can be borne by a stream of water varies with the current. The mechanics of the process are somewhat complicated, but these hardly require discussion here. If then a sample of ground silica consisting of grains of varying size be placed in the elutriator it is possible to separate off the very finest from the coarser and also to grade the sample into as many 'fractions' as are required. The fractions can be recovered and weighed if necessary by placing a filter under the outflow and the whole process treated quantitatively. Coarse particles can be withdrawn at D. If quantitative work is to be done the initial current at A must be kept constant. This is done quite easily by introducing a water-container or reservoir. A very simple form of this is shown in text-fig. 2.

It consists of a wide bell-jar A open at both ends. It is fitted with a cork B bearing three holes and inverted. C is the inlet from the water-tap, D is the outlet to the elutriator, and F is the overflow to the sink. This overflow should obviously be a wide tube. Water is let in by the inflow at such a rate that the reservoir is kept full when the elutriator is in full use. This reservoir can be placed at any convenient height and a constant rate of flow maintained. It will be obvious that a considerable range of current can be obtained by raising or lowering the reservoir and making other adjustments which will suggest themselves. If a reservoir is used a clip (F, text-fig. 1) is convenient, but for quantitative work it must of course be kept open.*

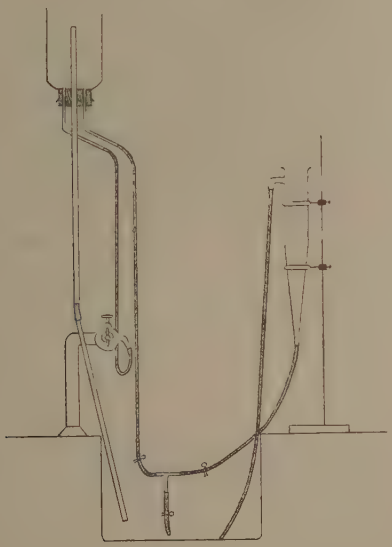
*Some biological applications.*—The primary use to which I put the instrument lately was the investigation of the swimming powers of fresh-water ostracods. The second antenna of fresh-water ostracods may or may not possess so-called *swimming setæ*. Some genera do while others do not. In one genus some species may possess these setæ

* The only part of the apparatus which requires specially making is the elutriator proper. This is obtainable from Messrs. Philip Harris, Edmund Street, Birmingham, at a cost of about 7*s*. 6*d*.

while others do not. Again, some ostracods swim while others crawl, and some may swim only when they cannot crawl.

The swimming power of ostracods is not then a simple problem depending on the presence or absence of setæ on the second antennæ, but a great many other factors are involved. A large number of genera and species have been investigated, but it is not proposed to give the results of this particular investigation here. It will, however, be seen at once that for this investigation it was necessary to devise some method by which the ostracods could be supported without providing any solid material on which they could crawl.

Text-fig. 3.



The first application was then the investigation of the swimming power of ostracods. This naturally led to the investigation of the swimming powers of other Entomostraca and freshwater animals, generally including insects. Many aquatic animals may or may not possess the power of swimming and at the same time may or may not have the power of attachment. A piece of string with a small weight at the end let down into the elutriator has a remarkable effect on such animals as *Gammarus pulex* and *Corixa geoffroyi*. The animals swim to the very lowest part of the apparatus and will even

crawl down the inlet tube, but they will readily attach themselves to the string and remain there for an hour or so. It is possible then to keep such animals as these either swimming vigorously or remaining stationary in a rapid current of water. Some Entomostraca definitely face the current, while others float on it. *Diaptomus gracilis*, which one always looks upon as a strong swimming copepod, does not swim in the elutriator, but is easily carried over by a slow current. Nearly all species of *Cyclops* face the current and are to be obtained from the lowest part of the apparatus. Some Cladocera show remarkable powers of swimming. *Daphnia pulex* and *D. longispina*, contrary to one's expectations, face the current and swim head downwards towards the lowest part of the apparatus. The two species have, however, very different powers of swimming, and a complete separation of these two species can be made in the elutriator. Another application of the instrument is the separation of entomostraca from mud or silt, and for the separation of ostracods I know of no better method. It is more than likely that the instrument may be useful for physiological experiments. Small fish may be kept swimming rapidly for some time in currents of varying strength, or, again, fresh-water or salt-water algæ may be kept in a stream of running water.

Sir Sidney Harmer expressed his interest in Mr. Lowndes's communication and enquired whether the author had had an opportunity of investigating, in his apparatus, the behaviour of the larvæ of sessile invertebrates during the period immediately before their fixation.

The President having expressed the thanks of the meeting, Mr. Lowndes replied.

## Artificial concealment devices in Nature. By Major R. W. G. Hingston, M.C.

Major Hingston stated that concealment devices for securing protection were widespread throughout Nature. Insects especially supplied numerous examples—such as stick-insects, leaf-insects, moss-insects, bark-insects—which closely resembled their natural environment. But almost all these examples had one thing in common, viz., the animals had themselves taken no part in the manufacture of their concealments. The stick-insect, for example, lived amongst twigs and sticks. Nature had given it a stick-like shape and had supplied it with surroundings that would suitably protect it.

But there was another class of instances, hitherto much neglected, in which we find a different plan employed. Nature did not supply surroundings to match the animal; but the

animal, in what we may describe as an artificial manner, manufactured the surroundings for itself. These creatures are the orb-weaving spiders, and their artificial devices in tropical countries take on many varied forms. *Cyclosa tapetifaciens* of British Guiana makes a flat carpet of débris in the centre of its snare and sits on that carpet in perfect concealment. Other species of *Cyclosa* make strings of pellets. The pellets consist of insect-fragments tied together with silk ; and the spider, which is the same size, shape, and colour as the pellet, sits in the string perfectly concealed. Other species collect small bits of bark, string the bits along one diameter of the snare, then seat themselves at one end of the string where they look like one of the bits. One black and white species, *Cyclosa tremula* of British Guiana, which is different in colour from its brown pellets, has the habit of vibrating very rapidly, which act changes its colour and makes it similar to that of its pellets. Different species of *Uloborus* manufacture bands in their snares, and leave a gap in the middle of the band which they fill with their own bodies. The result is that the spider makes itself part of the band and cannot be detected when seated in its snare. Different species lay out these bands in distinctive manners ; one kind puts the band vertically, another horizontally, another obliquely, another puts three bands in a triradiate arrangement, another puts four bands in the form of a cross. Other species, for instance *Cyclosa caudata*, string out their cocoons across the snare and seat themselves at the end of the string, where they look like one of the cocoons. Other kinds of *Cyclosa* place bright wavy spiral threads through the snare, which have the effect of confusing the Hymenopteron enemy when it is attempting to pounce on the spider. Others combine these confusing threads with concealing pellets and bands. Other species belonging to the Argiopid group manufacture silvery zigzags with which the silvery body of the spider blends. One species makes the zigzags into a silvery carpet on which it sits at the centre of the snare ; another group spreads the zigzags in the form of ribbons through the snare, either as vertical bands or in a tri-radiate formation, or in the shape of a St. Andrew's Cross. In these cases the spider sits in a gap at the centre and makes itself part of the zigzag arrangement.

Forty of these different devices were shown, and it was maintained that the only view which could explain their construction was that they were of concealing value to the spider.

Mr. J. T. Cunningham suggested that the effect of the pellets and bands attached to the spider's snare might be rather to strengthen it than to aid in the escape of the spider.

Mr. H. N. Ridley remarked on the use of the shield in the spider's web, and related how he had seen in Singapore spiders dart behind the web on the approach of the spider-hornet. He suggested that the cross in the web was to deceive insects approaching the net, who would take the crossbars for sticks or evidence that the web was not there.

Lt.-Col. J. H. Tull Walsh agreed with Major Hingston that, in the case of spiders, to produce confusion is to obtain protection. A method, not mentioned by the lecturer, is common to some species and he had often observed it in India : at the approach of a large insect enemy, or even if a shadow suddenly falls on the web, it is violently shaken ; so rapid is the vibration that the snare becomes a blur and the spider is practically invisible.

Captain C. Diver asked Major Hingston whether he had made any observations on the frequency with which the more complicated webs were rebuilt, as it was usual among British Epeirids to remove the whole web (except for the main cable) and rebuild it each day, and even twice a day at certain periods of their life (*Epeira diadémata*). With *Argiope*, using silken bands only, such rebuilding would be simple ; but it would be interesting to know what, for instance, *Cyclosa* did with its line of cocoons during rebuilding. He suggested that the diagonal to which these were attached might perhaps be left *in situ* like the main cables.

Mr. I. H. Burkill likened the symmetrical designs in the spiders' webs to the lines in flowers theoretically called honey-guides, pointing out that as the lines of the honey-guides are supposed to direct the visiting Hymenoptera to the centre of the flower, so should the symmetrical pattern of the web direct, not confuse, the hunting Hymenoptera in their search for the spider, unless it be that the vision of the hymenopteron is so inferior that the larger pattern of the web is unappreciated, the visitor only seeing clearly at very close range the solid substance in part, and while it is hunting along it the spider has its chance of escape. The dimensions of the spiders' designs are greater than the designs called honey-guides in general.

Major Hingston replied, and the President conveyed the thanks of the meeting to him.

The following paper was read in title, and the announcement made that the author would give an account of it at a later meeting in the Session :—Relative growth of mandibles in Stag-Beetles (Lucanidæ). By Professor Julian S. Huxley.

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